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LOS ALAMOS TRANSURANIC WASTE SIZE REDUCTION FACILITY

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ABSTRACT

A transuranic (TRU) Waste Size Reduction Facility (SRF) was designed and constructed at the Los Alamos National Laboratory during the period of 1977-1981. This paper summarizes the engineering development, installation, and early test operations of the SRF. The facility incorporates a large stainless steel enclosure fitted with remote handling and cutting equipment to obtain an estimated 4:1 volume reduction of gloveboxes and other bulky metallic wastes.

INTRODUCTION

Since 1971, TRU solid wastes generated at Los Alamos National Laboratory have been segregated from other wastes, specially packaged, and placed in retrievable storage to comply with Federal requirements. At present over 5200 m^3 of TRU waste is stored at Los Alamos, almost 50% of which is made up of large metallic items such as gloveboxes, process equipment, ductwork, and piping. Criteria for eventual acceptance of this waste at the Waste Isolation Pilot Plant (WIPP) facility include limitations on the size, weight, and design of waste packages. The original concept of the SRF was developed in mid-1977 as part of the overall process of decontamination/rehabilitation of an old plutonium processing facility. In addition to allowing waste packaging in a proper size and type of container for the WIPP, SRF treatment reduces waste volume and handling and disposal costs substantially.

ENGINEERING DEVELOPMENT OF THE FACILITY

BUILDING STRUCTURE

The SRF was planned to occupy an existing 12.2-m by 15.2-m by 5.6-m high room available in the old plutonium processing plant. Because the SRF glovebox enclosure was designed to fit that room and let to bid before Los Alamos decided a new SRF building was needed, the building was sized to fit the enclosure.

The SRF is housed in a high-bay, one-story building, with a mezzanine for mechanical equipment. The roof and the mezzanine floor are of steel joists and metal decking with concrete. Exterior walls are plastic veneer finish on polystyrene insulation and gypsum board sheathing over structural steel studs, while interior walls are 15.9-mm gypsum wallboard on metal studs. Based on this overall construction, a TRU inventory limit of 100 g was established for the facility.

An external view of the building is shown in Figure 1. Figure 2 shows the main floor plan with inside dimensions of 11.9 m by 15.5 m. Change room, shower, and toilet facilities are under the mezzanine.

The supply and two exhaust air systems of 1-m^3/s capacity, each located on the mezzanine, are synchronized to maintain a negative pressure in the building and a negative pressure in the enclosure relative to the building interior. Each system consists of filters, fan, and stack designed to meet specifications in the DOE Nuclear Air Cleaning Handbook, 76-21. The enclosure system is a Zone I classification requiring two-stage, high-efficiency particulate air (HEPA) filtration with a flame arrestor before the prefilters and the HEPA filters. The high bay area is a Zone II classification requiring single-stage HEPA filtration. Both systems have 85% efficient filters upstream of the HEPA filters and are exhausted up stacks extending 3.7 m above the building roof. Air-sampling ports are provided. The fan motors, coupled to fluid drives, allow automatically adjusted fans to maintain the necessary negative pressure relationships.

The building heating and ventilating system brings in fresh air through prefilters, a heat recovery unit, bag-type filters, and a gas-fired heater. The heat recovery unit is an air-to-air type that recovers available heat in the enclosure exhaust air. The two speed supply fan motor maintains proper building pressure when both exhaust fans are on and when only the high bay exhaust is on. A modulating gas flame in the heater maintains accurate temperature control for both high and low air-flow conditions.

ENCLOSURE AND PROCESS DESIGN

The SRF enclosure design isolates a waste item section for disassembly and reduction to an acceptable size for packaging. Many size reduction techniques were considered before plasma-arc cutting was chosen. Crushing and shredding were rejected because of excessive equipment size and maintenance requirements. Several cutting methods were considered. Both laser and arc-saw were judged too experimental at that time. Gas and plasma-arc cutting were considered the most appropriate for the SRF because of ease of operation and maintenance, cutting effectiveness, and lower cost. The best cutting process for stainless steel proved to be the plasma-arc torch, which is simple to operate, has a high cutting rate, is a proven design, and is readily available. A potential drawback to this method is the resulting metal fumes.

The 9.1-m by 4.6-m by 4.6-m high enclosure is divided into four modules according to function: an airlock module, a disassembly module, a cutting module, and a packaging module (Figure 3). These modules are assembled on a base pan that provides a foundation for the enclosure and a catch basin for cutting wastes. The enclosure has a stainless steel skin with a mild steel external skeleton framework of 7.6-cm by 10-cm rectangular tubing. Each module has multiple gloveports and windows. All interior corners were rounded to facilitate decontamination.

Ventilation for the enclosure includes both primary and secondary air-filtration systems. The enclosure operates in a negative pressure range of 62-498 Pa with a maximum allowable negative pressure of 1493 Pa. Normal air flow is approximately 0.5 m^3/s, or six air changes per hour. Air can enter the enclosure at any of three locations through a HEPA filter. The filter not only reduces the load on downstream filters, but also protects the building from contamination in the event of positive pressurization of the enclosure. Varying operations dictate specific air flow patterns (Figure 4). Two inlets are provided in the airlock module (one below and one above the false ceiling), and a third in the bagout module. A bypass air system incorporating a HEPA filter is provided around the inner airlock doors to allow positive air flow through the airlock at all times during operation and especially when the outer airlock doors are open. Air exhausts through roughing filters at two ports in the cutting module. During operation, these air-flow patterns minimize migration of contamination to other modules. A secondary internal air system in the cutting area reduces smoke and fume buildup by filtering through an electrostatic precipitator which helps to reduce loading of the exhaust filters in the primary air-exhaust system.

The enclosure contains two categories of equipment. Manually operated, lightweight equipment is used primarily for disassembly of waste. This equipment, which is operated through the gloveports in the enclosure, consists of hand tools, impact wrenches, chisels, and saws. The remotely operated heavy equipment consists of the following: a 1820-kg capacity bridge crane, a 2730-kg capacity positioning table, an electromechanical manipulator, and a plasma-arc cutting torch. Equipment selection was based on ease of operation and maintenance, and overall reliability. Whenever possible, all supplementary units to the major equipment, such as power supplies and controls, are located outside the enclosure for ease of maintenance. Gloveports were positioned to enhance equipment maintenance.

INSTALLATION OF EQUIPMENT

ENCLOSURE

The SRF enclosure was fabricated by Stainless Equipment Company, Denver, Colorado, in approximately one year. Because the building was still under design, completed units were stored until the building was occupied in August 1980. Figure 5 shows the partially assembled unit and Figure 6, the completed enclosure. Each unit was bolted to the base pan and the adjoining units. When all five units were assembled, all joints were seal welded on the inside and then ground and polished.

BRIDGE CRANE/MANIPULATOR

Construction of the bridge support steel had to proceed concurrent with installation and assembly of the enclosure (Figure 5). Support columns are located outside the enclosure and the rail beams and rails are inside. The six penetrations were sealed by "Gortite" neoprene bellows seals. The manipulator, crane, and bridge assembly were fabricated by Programmed and Remote Systems Corporation (PaR) of Minneapolis, Minnesota. The crane is a Coffing two-ton, two-speed, wire rope drum-type. The manipulator is a modified PaR 3000.

PLASMA-ARC CUTTING TORCH

The PCM-100 plasma-arc cutting system from Linde Division of Union Carbide Corporation best suited the need to cut thin stainless steel sheet. The unit was installed by placing it adjacent to the cutting module of the enclosure and extending the two power leads and two gas leads from the unit to the entry panel with 9.5-mm copper and aeroquip tubing. The power leads enter through a 9.5-mm bakelite panel in the stainless steel entry panel. Inside the enclosure, the standard hose-and-cable assembly supplies the cutting torch.

LIFT TABLE

A lift table capable of 360° rotation, horizontal movement of 4.6 m, and vertical travel of at least 0.9 m enables operators to position waste units for manual disassembly through gloveports and to move them to the cutting module. The modified lift table was made by American Manufacturing Company of Tacoma, Washington. Installation required welding a piece of 2.5-cm by 2.5-cm stainless steel angle to the base pan of the enclosure for use as a track. Power in the form of 480-V, 30-A, 1-phase was brought through hermetically sealed couplings welded into the entry panel.

ELECTROSTATIC PRECIPITATOR

An electrostatic precipitator was installed to filter and recirculate 0.5 m^3/s of air within the enclosure. The unit, manufactured by United Air Specialists of Cincinnati, Ohio, is fitted with manually controlled, pneumatic powered vibratory cleaners. The 480-V, 3-phase power is supplied through a cable which is sealed at the entry panel penetration.

FACILITY COSTS

The total capital cost of the Los Alamos TRU waste SRF was approximately $875 000 (Table 1). These funds were expended during the period 1978 through 1981.

TEST OPERATIONS

The first tests of the cutting system began in May 1981 using miscellaneous thin sections of stainless steel. It was immediately apparent that maintaining the required 1.6-mm to 6.4-mm standoff distance would be difficult with the manipulator. A mechanical torch holder was developed which flexes approximately 4 cm, allowing the torch to track along the surface being cut.

Full-scale cutting of clean stainless steel gloveboxes began in early October 1981. The conductive smoke particulates quickly shorted the collector plates in the electrostatic precipitator. The roughing filters became loaded in just a few minutes. The HEPA filters plugged after about one full day of cutting. Changing the plasma gas from nitrogen to argon greatly reduced the smoke but then clearing the cut became a problem, as the manufacturer suggested it would. Fusing of the molten metal in the cut prevented separation of the cut pieces. When the plasma gas was changed to a mixture of 6% hydrogen in argon, the molten metal problem improved but was still troublesome, especially for thin metal. A further increase in the hydrogen concentration to 20% has made the cut quality adequate but not optimal.

The electrostatic precipitator was purchased as a self-contained unit with its own blower and air-operated vibratory cleaner. First it was used to circulate air within the enclosure, independent of the exhaust system. Later, the blower and motor were removed and the power supply and collectors were mounted in front of the roughing filters at the exhaust ports. All air leaving the enclosure now passes through the precipitator. The vibratory cleaners have not worked well because metal fumes produced in cutting are conductive and tend to cover the collector plates with a thin, continuous coating that grounds the collectors but is not massive enough to be vibrated loose.

Rotation of the hydraulic lift table proved too rapid and jerky for accurate positioning of the workpiece. An adjustable flow valve obtained from the manufacturer was installed to reduce the speed.

OPERATIONS WITH CONTAMINATED WASTE

The first contaminated glovebox processed contained approximately 0.3 mg of ^{239}Pu. Cutting the "sandwich" construction of 1.59 mm of stainless steel, 6.35 mm of lead, and 6.35 mm of stainless steel placed high stress on various systems. The lead hindered cutting because the PCM-100 plasma torch does not produce enough secondary gas pressure to blow the melted lead clear of the cut. Not only were three cutting passes required to clean out the lead, but lead fumes coated the collector plates of the electrostatic precipitator, causing the same shorting problems as cutting stainless steel with nitrogen gas. These problems forced the roughing filters to again bear the brunt of prefiltering protection for the HEPA filters. The glovebox was finally reduced in volume by a factor of about 4:1.

Several improvements which must be made are: (1) redesign the roughing filter change-out to free the electric manipulator for its prime function of continous cutting with the plasma torch; (2) design and fabricate a variety of manual remote handling tools; and (3) protect several enclosure windows against possible breakage during packaging.

FUTURE

The SRF is an experimental production-oriented facility, designed to reduce the volume and permit repackaging of TRU metallic waste items. Planned studies should provide techniques to cope with the Laboratory's dynamic requirements for TRU waste reduction and packaging. Within the constraints of the basic facility, modifications will be made as operating experience is gained. For example, design changes in the bagout area will accommodate WIPP waste storage containers.

Before items contaminated with gram quantities of transuranics are processed, a final Safety Analysis Report must be generated and approved. At full operation with a staff of three (one scientific and two technical) a weekly process rate of two standard gloveboxes (3 m by 1.5 m by 1.5 m) reduced in volume by 4:1 is expected.

ACKNOWLEDGEMENT

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TABLE 1. FACILITY CAPITAL COST

ITEM/WORK		APPROXIMATE COST
GLOVE BOX ENCLOSURE		$230 000
MANIPULATOR/HOIST SYSTEM		126 000
PLASMA TORCH		6 000
SUPPORT STEEL		5 000
LIFT TABLE		7 000
MISC. COMPONENTS		20 000
INSTALLATION, FACILITY PREP.		45 000
ENG. DESIGN SUPPORT		11 000
FORKLIFT		25 000
BUILDING DESIGN/CONSTRUCTION		400 000
	TOTAL	$875 000

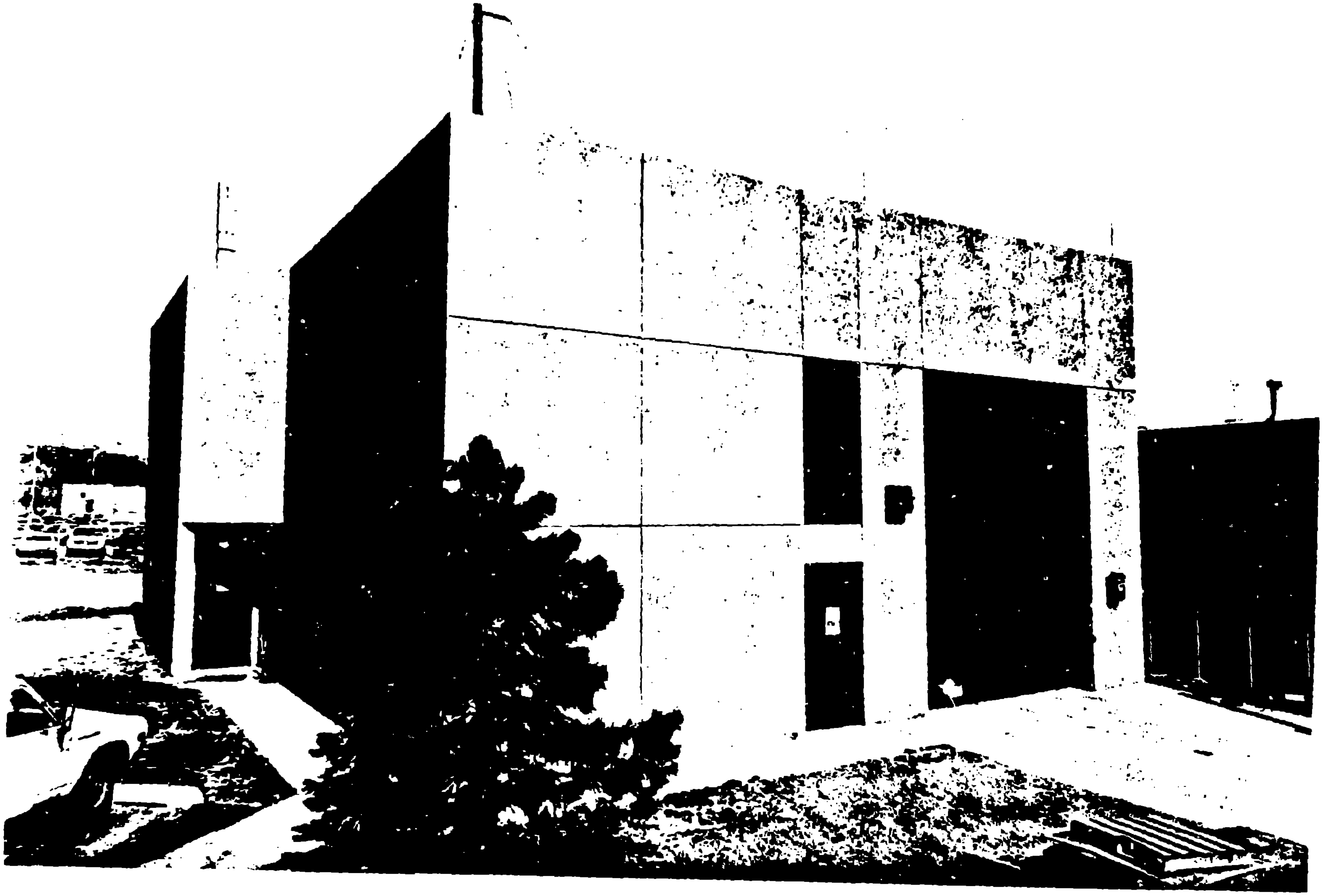

FIGURE 1. South View of Building

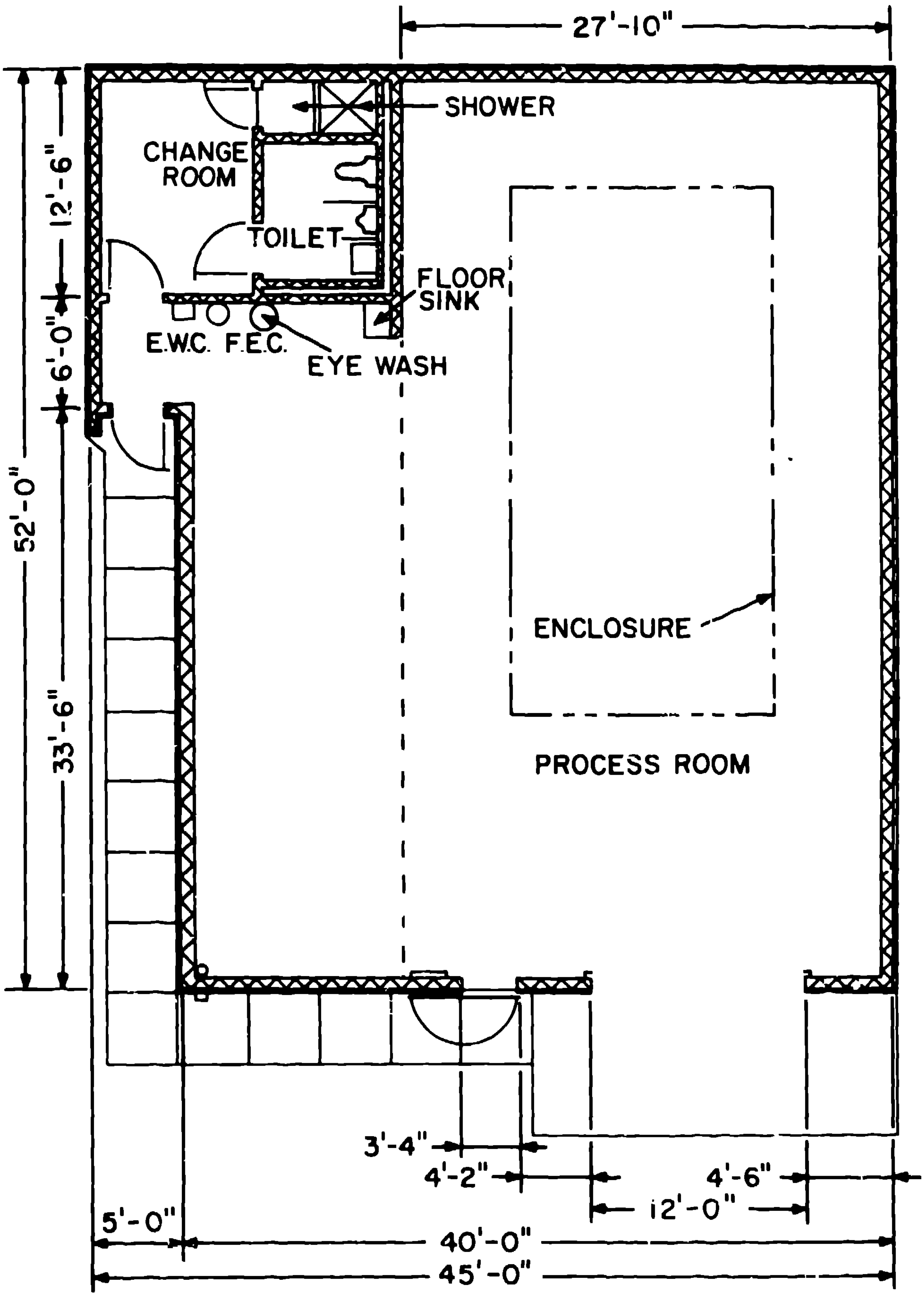

FIGURE 2. MAIN FLOOR PLAN

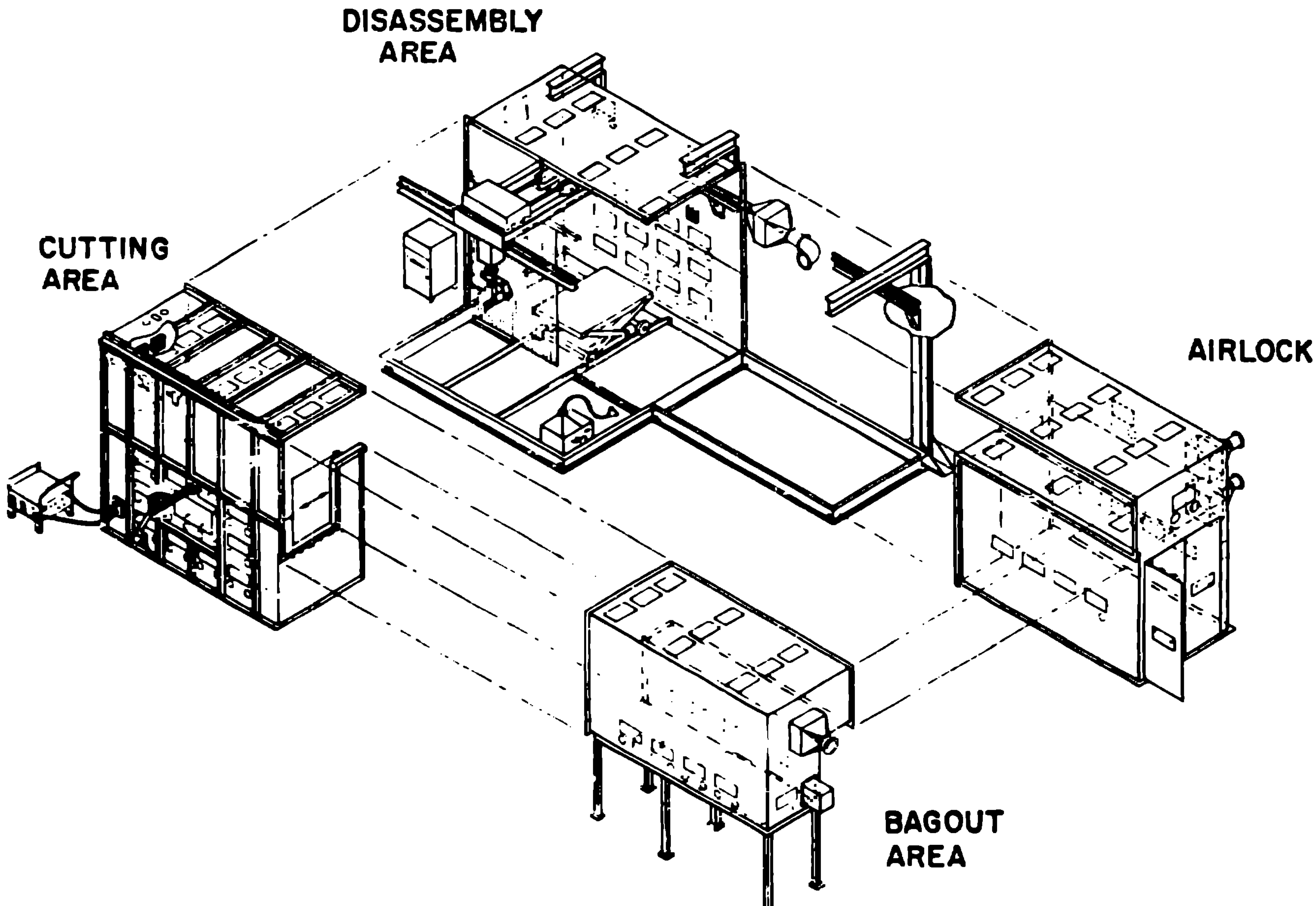

FIGURE 3. ENCLOSURE MODULES

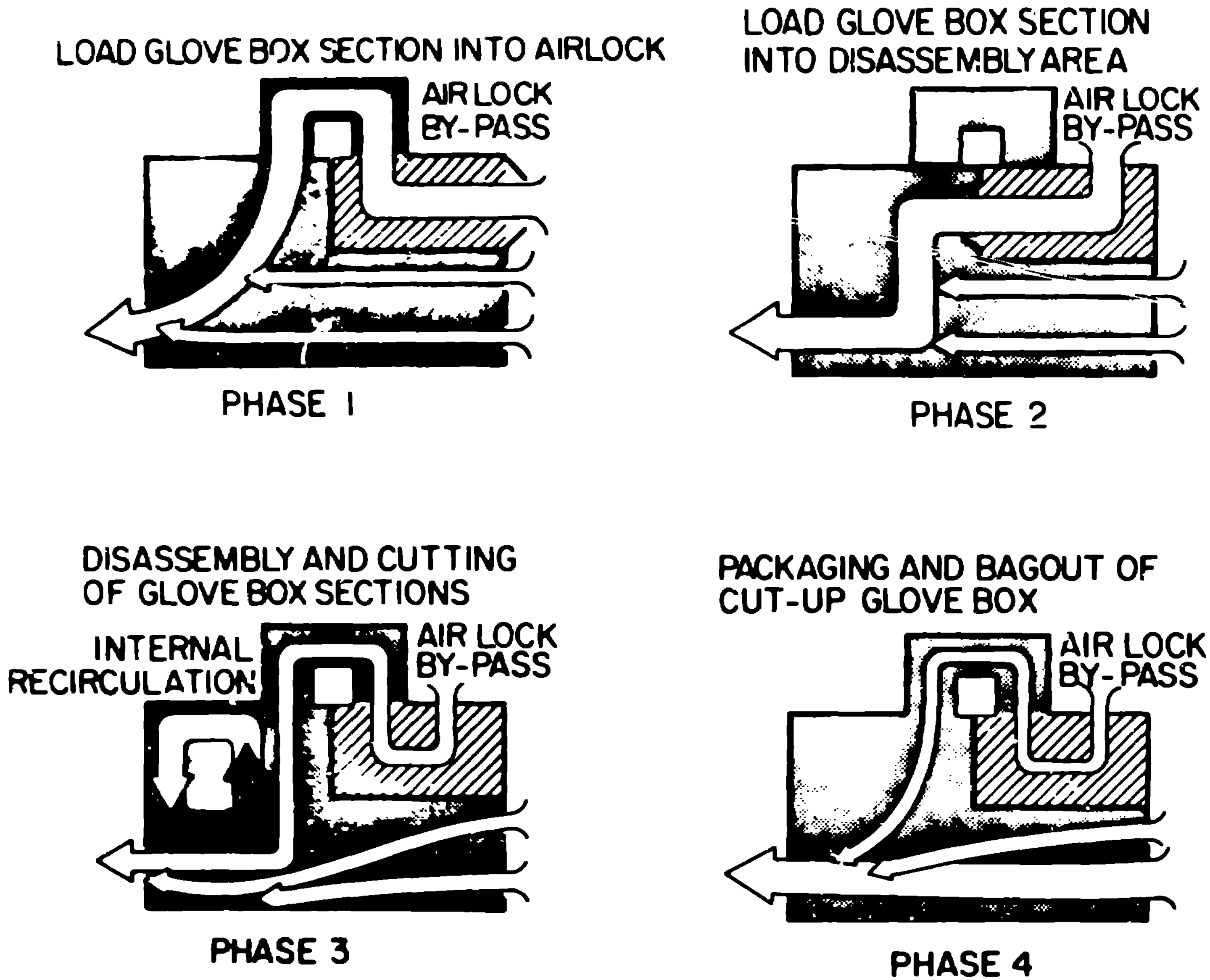

FIGURE 4. AIR FLOW PATTERNS

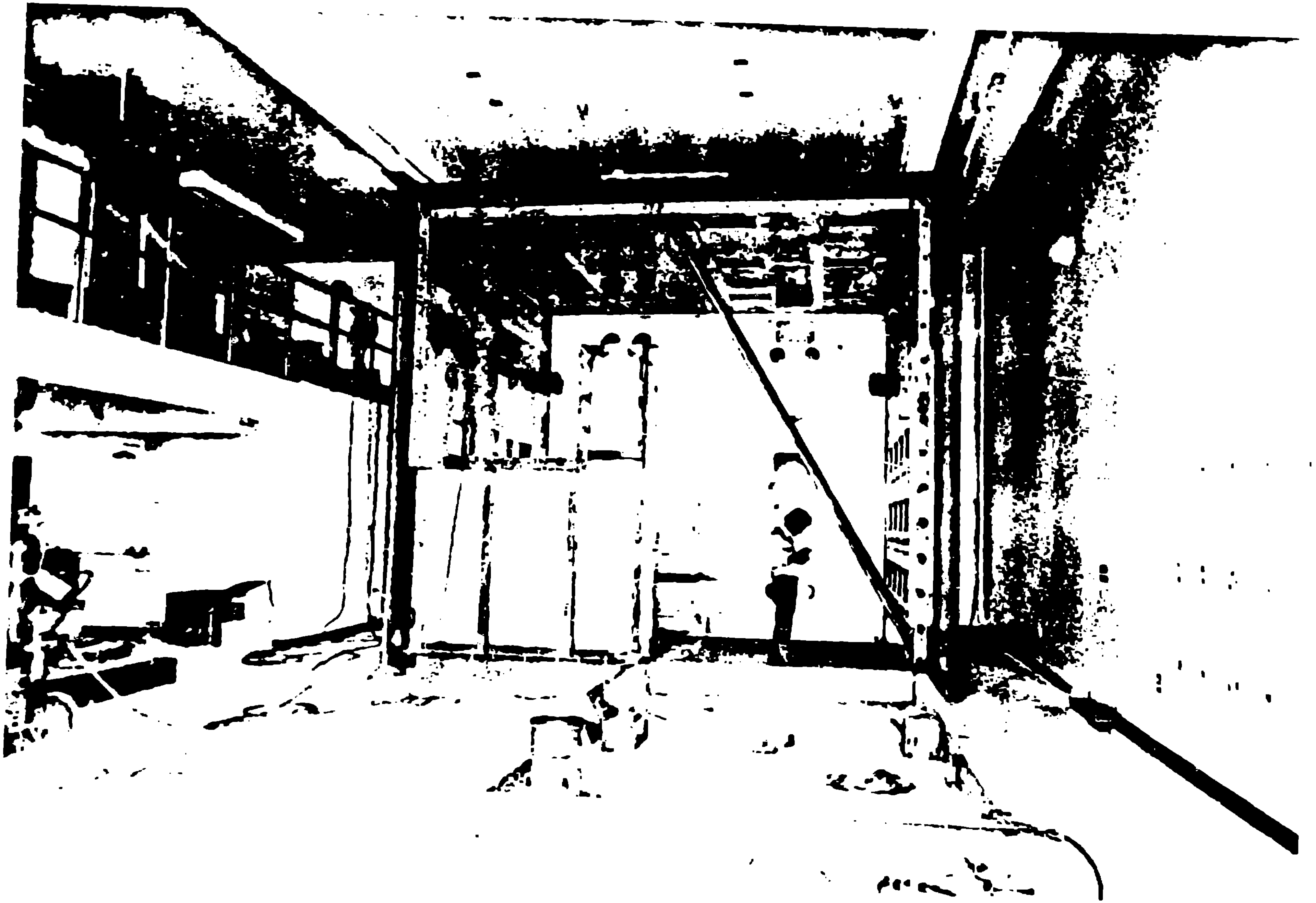

FIGURE 5. PARTIAL ASSEMBLY--ENCLOSURE

FIGURE 6. ALMOST COMPLETE ENCLOSURE